IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent application of:

Applicant:	Hans Kuehn
Application No:	10/716,167
Filing Date:	November 18, 2003
Title:	PLASTIC TUBE BODIES, AND METHOD FOR PRODUCING THEM
Examiner:	Barbara J. Musser
Art Unit:	1773
Docket No.	KUHNP0101USA

VERIFICATION OF A TRANSLATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, the below named translator, hereby declare that my name and post office address are as stated below; that I am knowledgeable in the English language and in the language of the following document:

German Patent Application No. 196 17 349.3

and I believe the attached English translation to be a true, accurate and complete translation of this document; and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: July 26, 2006

Full name of translator: Albert BENDER

Signature of the translator: Albert Bender

Post Office Address: JONES DAY
Prinzregentenstr. 11
80538 München
Tel.: 0 89-20 60 42-200
Fax: 0 89-20 60 42-293

R:\FORM.MST\PATENT\Verification of translation.wpd

97922926.7
Hans Kühn

April 12, 2006
K100327PCEP MR/ABB/ab/rr

Multi-layer Injection Moulding Method

1. Technical Field

The invention relates to an injection moulding method for plastic articles for the manufacture of containers for the storage of fluids as well as to an injection moulding device for thermoplastic materials as well as to containers for the storage of fluids which are produced by means of said method.

2. Prior Art

Containers made from thermoplastic materials are already known where the container body is produced in one manufacturing step by means of an injection moulding method. In other methods of the prior art, at first, a foil-like material is produced from which then, for example, cylinder-shaped bodies are formed, the joints of which are sealed by means of a welding line or a glue line. In one of the openings of the cylinder-shaped tube, then a container shoulder having an integrated closure region, such as a thread closure, a flap closure or a mounting cap, is inserted which are tightly connected with the container body by means of ultrasonic welding or high-frequency welding. The remaining opening serves for the feeding of the container and is closed after the feeding by means of welding or by inserting of a closure bottom that is connected to the container body by means of ultrasonic welding or high-frequency welding. Because of the different properties of the fluids, the container can be filled with, an appropriate selection of the material being suitable for the container wall is made. Criteria for the

selection of the material of the container body are, for example, the aggressivity or the easy volatility of a fluid or a desired inert behavior between the fluid and the container wall, as is mostly necessary for medically active substances.

Precisely for medical or pharmaceutical agents, a diffusion of the agent or one of the components is extremely undesirable, since the loss of the volatile components means that the percentage quantitative composition no longer corresponds to the original data so that a medically prescribed dosage which is based on the original composition of the agent is no longer guaranteed.

Further, by means of diffusion of the volatile components which frequently serve also as solvents, a change in the consistency has to be registered which can lead to more rapid aging due to drying out or due to a poorer applicability.

Since, however, individual materials are able only really to fulfil all the requirements placed on them (such as, for example, a good compatibility with the agent and impermeability for specific volatile constituents thereof) consideration has already been given to various agents made from different multi-layer films which are produced by a calendering method. Here, the various materials are extruded and are calendered in a roll configuration, that is to say rolled to form films or multi-layer films which are then welded to the described cylindrical bodies.

However, the shoulder pieces which are inserted into said cylindrical bodies for closure purposes do not have the properties of the container body since these are produced in a conventional manner by means of injection-moulding methods, and consist of only one layer of material, so that through the shoulder region of the container still the volatile components can diffuse out.

Until now, the only solution for a complete diffusion protection is the provision of cost-intensive metal containers which are complicated to produce and which

constitute a natural diffusion barrier because of the molecular density of metal. These metal containers can be provided with an additional layer in the interior in order to ensure an inert behavior between the fluid and the container wall. However, the production of metal containers is not only very much more complicated in the fabrication itself because of very many individual steps (rolling, coating with a plastic material, forming the containers, folding and flanging the longitudinal seam, etc.), but the fabrication periods and the material costs are also substantially higher.

Therefore, it is the object of the invention to provide a method respectively a device for producing containers, in which the containers produced can, on the one hand, be manufactured simply and cost-effectively in terms of production engineering and, on the other hand, have an excellent diffusion protection.

3. Summary of the Invention

This object is solved by the invention in that a method for the production of containers for the storage of fluids is provided which comprises the following steps:

- filling at least two feeding containers each with a first thermoplastic material in the first feeding container and a second thermoplastic material in the second feeding container;

- plasticizing the first and second thermoplastic materials in the respective feeding containers;

- injecting the first and second thermoplastic materials through an annular nozzle having at least two concentrically arranged annular nozzle gaps where the delivery rate is essentially the same in terms of direction and magnitude for the first and second materials with the result that the

homogeneity of the first and second materials is maintained after leaving the annular gaps;

- injecting the plasticized materials into a mold cavity of an injection mold with the result that the homogeneity of the individual plasticized materials that exists after leaving the annular nozzle is also maintained in the mold cavity.

Another aspect of the invention relates to containers which are produced by means of the above method.

Moreover, another object of the invention is a device for carrying out the above method.

The containers which are produced according to the invention are suitable for various uses such as, for example:

- tubes for cosmetic, medical, pharmaceutical and hazardous media or food stuffs, etc.;

- semi-rigid, bottle-shaped, or can-shaped containers for cleaning agents, chemicals, biological materials or consumer articles, etc.;

- rigid bottle shaped or can-shaped containers for food stuffs such as wine or juices, chemicals such as acids and bases, etc.;

- tanks for the embedding within the ground are concrete, etc., for diverse substances.

The thermoplastic materials are separately inserted into the respective feeding containers, wherein each feeding container can be assigned to a particular later

layer or layers of the container to be produced. According to the number of the desired material components, the number of the feeding containers has to be selected.

The thermoplastic materials are plasticized by means of thermal influence so that the materials being ready to be processed by injection moulding is transported by means of a line network into an annular nozzle. By controlling the outlet rate respectively the outlet pressure of the material to be plasticized, a maintenance of the homogeneity of the individual plasticized materials is also achieved after leaving the annular gaps.

After leaving the annular gaps, the thermoplastic materials are injected into an injection mold, whereby the individual layers which are formed by the annular gaps within the injection mold are also substantially maintained in the solidifying condition and beyond said condition.

One advantage of the method according to the invention is the possibility to produce containers having already integrated closure region and shoulder region, which are characterized by complete multi-layers.

A further advantage resides in the very low production costs, since the steps otherwise required, such as inserting shoulder pieces and welding the parts to one another are no longer required.

Further, the method has the advantage that by means of the specific metering of the individual thermoplastic materials, it is possible for cost-intensive constituents to be optimally set, something which can have a substantial effect on the production costs. This may be explained using an example. Consideration is given to a previously known container whose wall consists of three material layers, the middle layer being an expensive infusion-inhibiting material. This layer makes up approximately 80 – 90 % of the container volume; only 10 – 20 % of the container

volume is down to the cost-effective inner and outer layer. If, for example, PE is used as cost-effective outer or inner material (approximately 1.60 DM/kg) and EVOH as the expensive middle material (approximately 12 DM/kg), this would mean material costs of approximately 10.96 DM/kg for an average tube. A reduction in costs to approximately 2.64 DM/kg can be achieved with the method according to the invention by optimizing the use of materials.

A further advantage resides in the fast injection technique since previous containers have had to be produced by extrusion, a technique which requires equipment which is more cost-intensive and requires longer production cycles.

A further advantage consists in the possibility of being able to operate a plurality of injection molds, specifically up to 144, in parallel.

The sub-claims are directed to advantageous embodiments of the invention. Due to the concentrical arrangement of the annular gaps, the material which is injected via the utmost annular gap into the injection mold, forms the outer layer of the container so that the thermoplastic material which is used there must be weldable for the later closure of the container in the rear region.

Also, the thermoplastic material which is injected via the inner annular gap, is maintained within the container as inner wall so that, as the case may be, a compatibility, that is a behavior which is poor in reaction respectively which is inert, has to be ensured between the thermoplastic material and the container fluid.

Another embodiment of the method according to the invention resides therein to arrange one or more layers of the material between the outer and the inner layer, whereby the further layers can have different properties.

A property which is particularly required for soluble and volatile substances, is a diffusion-inhibiting effect so that the container fluid as in case of medical,

pharmaceutical substances or perfumed substances does not lose agents or aromatic essences and therewith the indicated composition.

The thermoplastic materials which can preferably be used for the method are generally polymers such as polyethylene (PE) or polyethylene terephthalates (PET), polyethylene glycol terephthalates or polypropylene (PP). Polyamide (PA) or ethylenevinyl alcohol (EVOH) can be used for possible further layers situated between the inner or outer edge layers. However, it is also possible to use any other plastic materials which are processible by welding.

The method according to the invention provides the possibility not only to produce completed containers such as, for example, tubes, however also so-called preforms that are moldings for the later containers. Said blanks, for example for tubes, have the advantage that they can be produced with large savings in material. The reason for this resides in the minimal wall thickness of the tube lateral surface.

Because of the material-specific viscosity of plasticized plastic materials, it is only possible to inject thermoplastic materials up to a specific minimum wall thickness, particularly if multi-layers of plastic materials need to be arranged within a narrow gap.

This problem is solved by the method according to the invention by the injection molding of the so-called preforms, that is in the injection moulding not all final dimensions of the container are produced, however only the final dimensions which are in the region of the container shoulder and in the region of the container closure. The final dimensions of the container body, in particular length and wall thickness are achieved by later secondary finishing methods.

Preferably, said methods are cold-forming methods, in which the tube preforms are coldly stretched; here, the container body of the preform is stretched for a

factor of 3.5 or more, whereby, naturally, the wall thicknesses of the individual layers decrease. By means of said method, it is possible to reduce layers which consist of cost-intensive materials in their wall thickness (below 50 µm), so that a considerable portion of costs can be saved (up to 50 % compared to previous tubes). Further, due to the diminishing of the general wall thickness of the tube container, said container is softer and therewith easier to handle after it has been cut, printed, filled and welded.

In the following, one embodiment of the present invention is discussed with reference to the drawing. Here the Figures show:

Figure 1: A schematic view of a device for injection moulding for carrying out an injection moulding method for multi-layers;

Figure 2: A cross-section through a container having the detail K which is an enlargement of the layered structure;

Figure 2a: A plurality of various layer designs;

Figure 3: An injection-moulding device for a multi-layer injection-moulding method.

Figure 1 in principle represents the arrangement of an injection-moulding device whereby the feeding devices 20 a, b, ... in each case represent integrated devices for conveying, plasticizing and metering of thermoplastic materials. The number of the feeding devices is determined by the number of plastics to be used, respectively by the number of the material layers to be produced. Thus, for example, for the manufacture of a two-layer container, in which the outer layer consists of PP and the inner layer of PA, requires the use of two feeding devices in which, respectively, PP or PA are conveyed, plasticized and metered. However, in a container which has as inner layer, for example, another layer of PP, there is

no need to use a further feeding device, it is possible instead to undertake an appropriate subdivision (not represented) of the mass flows inside the lines 100, 200, 300, ...

Inside the feeding devices 20 a, b, ... the material is made available by being introduced into the accumulators 23 a, 23 b, ... and is conveyed by screws 22 into regions 21, in which it is plasticized by the influence of heat.

The plasticized material is fed by means of a tapering 24 into a network, in which it is maintained by means of regulation mechanisms (not represented) in a plasticized condition so that the thermoplastic materials have a condition which is optimal for injection moulding when reaching nozzle 10.

The plasticized materials are introduced into the mutually separated annular gaps 120, 220, 320 (compare Figure 3) of the nozzle 10 through the inlets which are arranged in the nozzle and communicate directly with the respective lines 100, 200, 300.

The inlet rate and the conveying pressure depend on the respective nozzle geometries, it being necessary inside the nozzle to take account of the sheer forces and compressive forces which arise, in such a way that the delivery rate of the individual materials and layers are essentially the same in terms of direction and magnitude.

It is possible, through ensuring this feature, for the homogeneity of the various layers to be maintained after they leave the annular gaps, since the layers do not mix with one another, that is to say the spatial unit of the individual layer components (for example PA, PET, EVOH, etc.) is essentially maintained in a layered fashion, with the result that continuous component layers are to be found, however, wherein the molecular properties as well as the interdependencies of the

individual materials respectively adhesion, compatibility and the like are still not known.

The material, which is still plasticized, is injected into an injection mold 30 (compare Figure 1) it being possible to construct the latter in different ways corresponding to the preform to be produced.

As soon as the injection mold is fed with the material, the solidification phase begins which can be supported by a cooling system within the mold.

Since, as a rule, the mold consists of a plurality of parts, opening the mold releases the work piece such that it can easily be ejected.

Injection-moulding technology can be used to connect a multiplicity (up to approximately 40) of injection molds to the conveying devices with the result that a high rate of production can be achieved. The number of tube layers to be produced depends on the individual material characteristics, on their various physical properties, and on the specifications of the containers respectively to be produced.

Figure 2 shows in cross-section a container according to the invention which was produced by means of the injection-moulding method according to the invention. Due to a preferred embodiment, the container is designed in dependence on the wall thickness and material selection as a tube, or is essentially maintained in its cylindric form, so that a type of bottle is formed.

Likewise, the represented thread design can be replaced in the region A (closure region) by another closure possibility, for example a cap or a hinged cover. However, the region which is enlarged in detail K, is common to all possible embodiments or designs which represent the cross-section of the container wall. The detail K shown in Figure 2 shows a three-layer wall, but equally possible are

double walls or multi-layer walls as can be seen in Figure 2a. What is decisive is that the number of layers is identical in the regions A (closure region), B (shoulder region) and C (container region), the container thus being formed in one piece in one production operation.

Different variations of layers are shown in Figure 2a, the different shadings corresponding to different materials. Only a few possible combinations are presented as material combinations, likewise also other combinations within the presented materials PE, PA, PP, PET, EVOH, PEN and PVDC are possible.

Figure 3 is a diagrammatic perspective representation of the injection-molding nozzle 10 according to the invention, wherein the 3 annular gaps 120, 220, 320 can be seen for a three-layered wall. The annular gaps 120, 220 and 320 are arranged concentrically and radially spaced from one another.

In addition, the annular gaps can have an axial spacing (not represented).

The annular gaps are connected by bores 100, 200 and 300 to a line system which is not represented. Of course, the number of feed lines and thus of annular gaps is not limited to the number represented, but depends, as already described, on the number of layers desired.

In the diagrammatic representation, the nozzle 10 is to be seen in one piece, but the unipartite production can be very complicated, with the result that a multipartite design, for example through screwed or welded joints, can be more favorable for production.

Patent Claims

1. Injection-moulding method for producing containers for the storing of fluids comprising the following steps:

   - filling at least two feeding containers (23a, b) each with a first thermoplastic material in the first feeding container (23a) and a second thermoplastic material in the second feeding container (23b);

   - plasticizing (21) the first and the second thermoplastic material in the respective feeding containers;

   - injecting the first and second thermoplastic materials through an annular nozzle (10) having at least two concentrically arranged annular nozzle gaps (120, 220) where the delivery rate is essentially the same in terms of direction and magnitude for the first and second materials with the result that the homogeneity of the first and second materials is maintained after leaving the annular gaps (120, 220);

   - injecting the plasticized materials into a mold cavity of an injection mold (30) with the result that the homogeneity of the individual plasticized materials that exists after leaving the annular nozzle (10) is also maintained in the mold cavity.

2. Injection-moulding method according to claim 1, wherein the thermoplastic material that is injected through the outer annular gap (320) is weldable.

3. Injection-moulding method according to claim 1, wherein the thermoplastic material which is injected through the inner annular gap (110) is compatible with the container fluid.

4. Injection moulding method according to claim 1, wherein at least another material layer is arranged between the outer and inner layer that has a diffusion-inhibiting effect on the container fluid.

5. Injection-moulding method according to claim 1, wherein the thermoplastic material which is injected through the outer annular gap (320) consists of polyethylene (PE), polyethylene glycol terephthalate or polyalkylene terephthalate (PET) or polypropylene (PP).

6. Injection-moulding method according to claim 1, wherein the thermoplastic material which is injected through the inner annular gap (120) consists of polyethylene (PE), polyethylene glycol terephthalate or polyalkylene terephthalate (PET) or polypropylene (PP).

7. Injection-moulding method according to claim 1, wherein the at least one layer which is arrangeable between the inner and the outer layer consists of polyamide (PA) and/or (PE) and/or (PET) and/or (PP) and/or ethylenevinyl alcohol (EVOH) and/or PEN and/or PVDC and/or polyethylene glycol terephthalate.

8. Injection-moulding method according to one of the preceding claims, wherein the containers are tube preforms.

9. Injection-moulding method according to claim 8, wherein the tube preforms can be processed by cold-stretch forming.

10. Container for the storage of fluids which are producible by the following steps:

    - filling at least two feeding containers (23a, b) each with a first thermoplastic material in the first feeding container (23a) and a second feeding container (23b);
    - plasticizing (21) the first and the second thermoplastic material in the respective feeding containers;

- injecting the first and second thermoplastic materials through an annular nozzle (10) having at least two concentrically arranged annular nozzle gaps (120, 220), wherein the delivery rate in direction and magnitude of the first and second materials are essentially the same, with the result that the homogeneity of the first and second materials are maintained after leaving the annular gap;
- injecting the plasticized materials into a mold cavity of an injection mold (30) with the result that the homogeneity of the individual plasticized materials that exists after leaving the annular nozzle (10) is also maintained in the mold cavity.

11. Injection-moulding device for the manufacture of containers having a ring-shaped nozzle having at least two concentrically arranged gaps (120, 220).

12. Injection-moulding device according to claim 11, characterized in that the concentrically arranged gaps (120, 220) are not directly connected with one other.

13. Injection-moulding device according to claim 12, wherein the gaps (120, 220) are radially respectively radially and axially spaced from one another.

14. Injection-moulding device according to claim 12 or 13, wherein the gaps (120, 220) are tapered in direction of the nozzle end.

Abstract

The invention relates to an injection-moulding method for plastics for the manufacture of containers for the storage of fluids as well as to an injection-moulding device for the simultaneous injection of multi-layers of thermoplastic materials as well as to containers for the storage of fluids, wherein the containers are producible in single pieces. The method allows the manufacture of containers for all kinds of fluids with the result that even difficult contours like threads or shoulder region which until now could only be manufactured separately, now can be manufactured in one continuous piece multi-layered by injection moulding.